

Real-Time Water Quality Deployment Report

Outflow of the Steady at Rambler Mine

September 15 to
November 23, 2021



Government of Newfoundland & Labrador
Department of Environment & Climate Change
Water Resources Management Division

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General

- The Water Resources Management Division, in partnership with Rambler Metals and Mining Canada Ltd., maintain one real-time water quality and water quantity station at the Outflow of the Steady.
- This station is situated downstream of the Nugget Pond Mill tailings management facility (Figure 1).
- On September 15, 2021, a real-time water quality monitoring instrument was deployed at the station Outflow of the Steady. The instrument was deployed for a period of 69 days. This was the third and final deployment for this station in 2021.
- During deployment maintenance, the stage (water level) equipment was successfully repaired.
- Water Resources Management Division staff monitor the real-time web pages regularly.

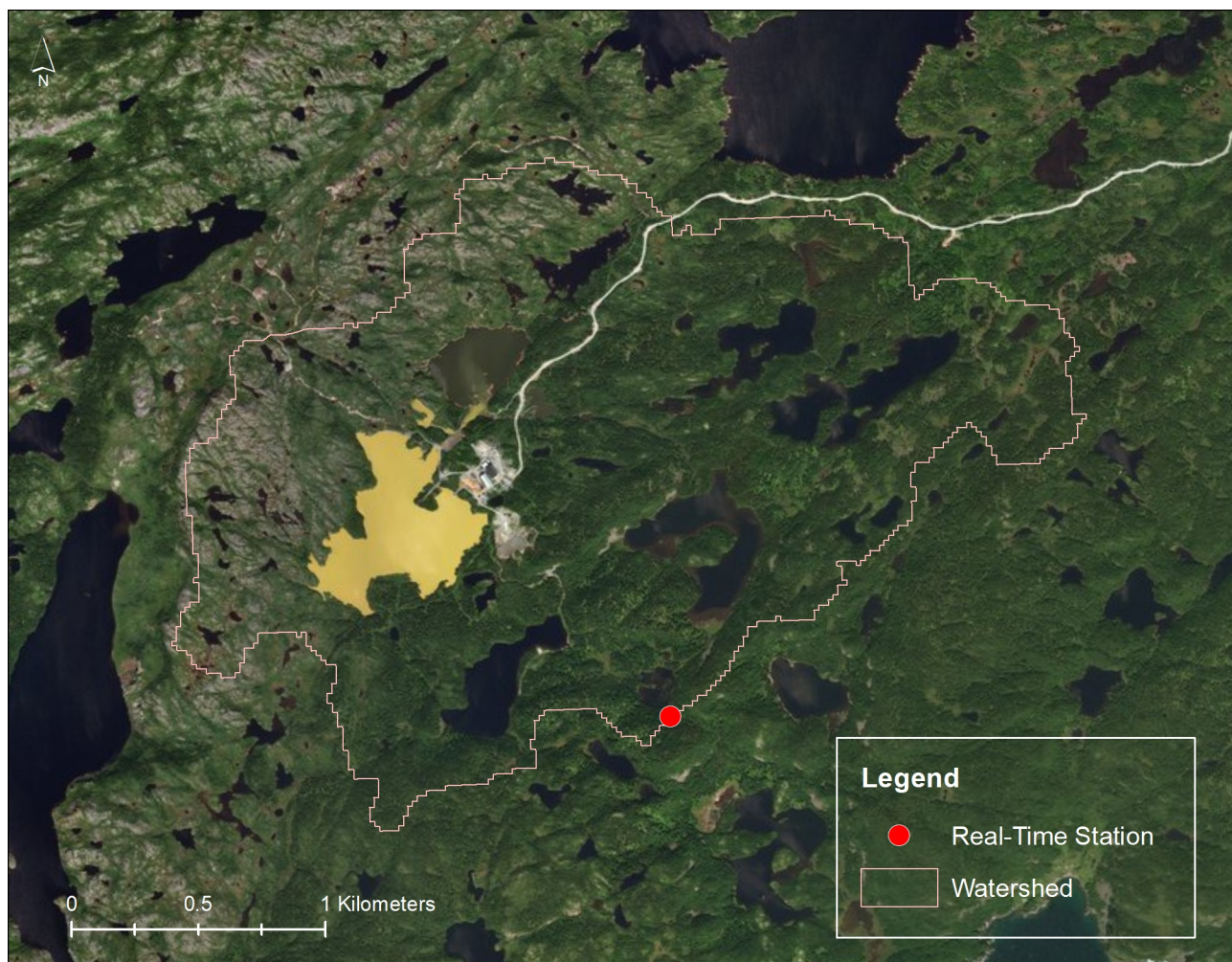


Figure 1: Location of the real-time station downstream of Rambler’s Nugget Pond Mill tailings management facility

Quality Assurance and Quality Control

- As part of the Quality Assurance and Quality Control protocol (QA/QC), an assessment of the reliability of data recorded by an instrument is made at the beginning and end of the deployment period. The procedure is based on the approach used by the United States Geological Survey.
 - At deployment and removal, a QA/QC Sonde is temporarily deployed adjacent to the Field Sonde. Values for temperature, pH, conductivity, dissolved oxygen and turbidity are compared between the two instruments. Based on the degree of difference between parameters recorded by the Field Sonde and QA/QC Sonde at deployment and at removal, a qualitative statement is made on the data quality (Table 1).

Table 1: Ranking classifications for deployment and removal

Parameter	Rank				
	Excellent	Good	Fair	Marginal	Poor
Temperature (°C)	<=+/-0.2	>+/-0.2 to 0.5	>+/-0.5 to 0.8	>+/-0.8 to 1	<+/-1
pH (unit)	<=+/-0.2	>+/-0.2 to 0.5	>+/-0.5 to 0.8	>+/-0.8 to 1	>+/-1
Sp. Conductance (µS/cm)	<=+/-3	>+/-3 to 10	>+/-10 to 15	>+/-15 to 20	>+/-20
Sp. Conductance > 35 µS/cm (%)	<=+/-3	>+/-3 to 10	>+/-10 to 15	>+/-15 to 20	>+/-20
Dissolved Oxygen (mg/L) (% Sat)	<=+/-0.3	>+/-0.3 to 0.5	>+/-0.5 to 0.8	>+/-0.8 to 1	>+/-1
Turbidity <40 NTU (NTU)	<=+/-2	>+/-2 to 5	>+/-5 to 8	>+/-8 to 10	>+/-10
Turbidity > 40 NTU (%)	<=+/-5	>+/-5 to 10	>+/-10 to 15	>+/-15 to 20	>+/-20

- It should be noted that the temperature sensor on any sonde is the most important. All other parameters can be broken down into three groups: temperature dependant, temperature compensated and temperature independent. Because the temperature sensor is not isolated from the rest of the sonde the entire sonde must be at the same temperature before the sensor will stabilize. The values may take some time to climb to the appropriate reading; if a reading is taken too soon it may not accurately portray the water body.

Deployment and removal comparison rankings for the station Outflow of the Steady deployed between September 15 and November 23, 2021 are summarized in Table 2.

Table 2: Comparison rankings for Outflow of the Steady station September 15 – November 23, 2021.

Station	Date	Action	Comparison Ranking				
			Temperature	pH	Conductivity	Dissolved Oxygen	Turbidity
Outflow of the Steady	September 15, 2021	Deployment	Excellent	Good	Excellent	Good	Excellent
	November 23, 2021	Removal	Excellent	Fair	Good	Excellent	Excellent

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- Deployment rankings were either 'excellent' or 'good' for all sensors.
- At removal, all sensors ranked 'excellent', to 'good' with the exception of pH which ranked 'fair'.
- There are a few circumstances which may cause less than ideal QA/QC rankings to be obtained. These include: the placement of the QA/QC sonde in relation to the field sonde; the amount of time each sonde was given to stabilize before readings were recorded; and deteriorating performance of one of the sensors.

Data Interpretation

- The following graphs and discussion illustrate water quality related events from September 15 to November 23 at the station Outflow of the Steady.
- With the exception of water quantity data (stage), all data used in the preparation of the graphs and subsequent discussion adhere to this stringent QA/QC protocol. Corrected data can be obtained upon request.

Outflow of the Steady

- Water temperature ranged from 1.76 to 17.57°C during this deployment period (Figure 2).
- Water temperature gradually decreased throughout the deployment into the late Fall. The changes correspond with ambient air temperature (Figure 2).

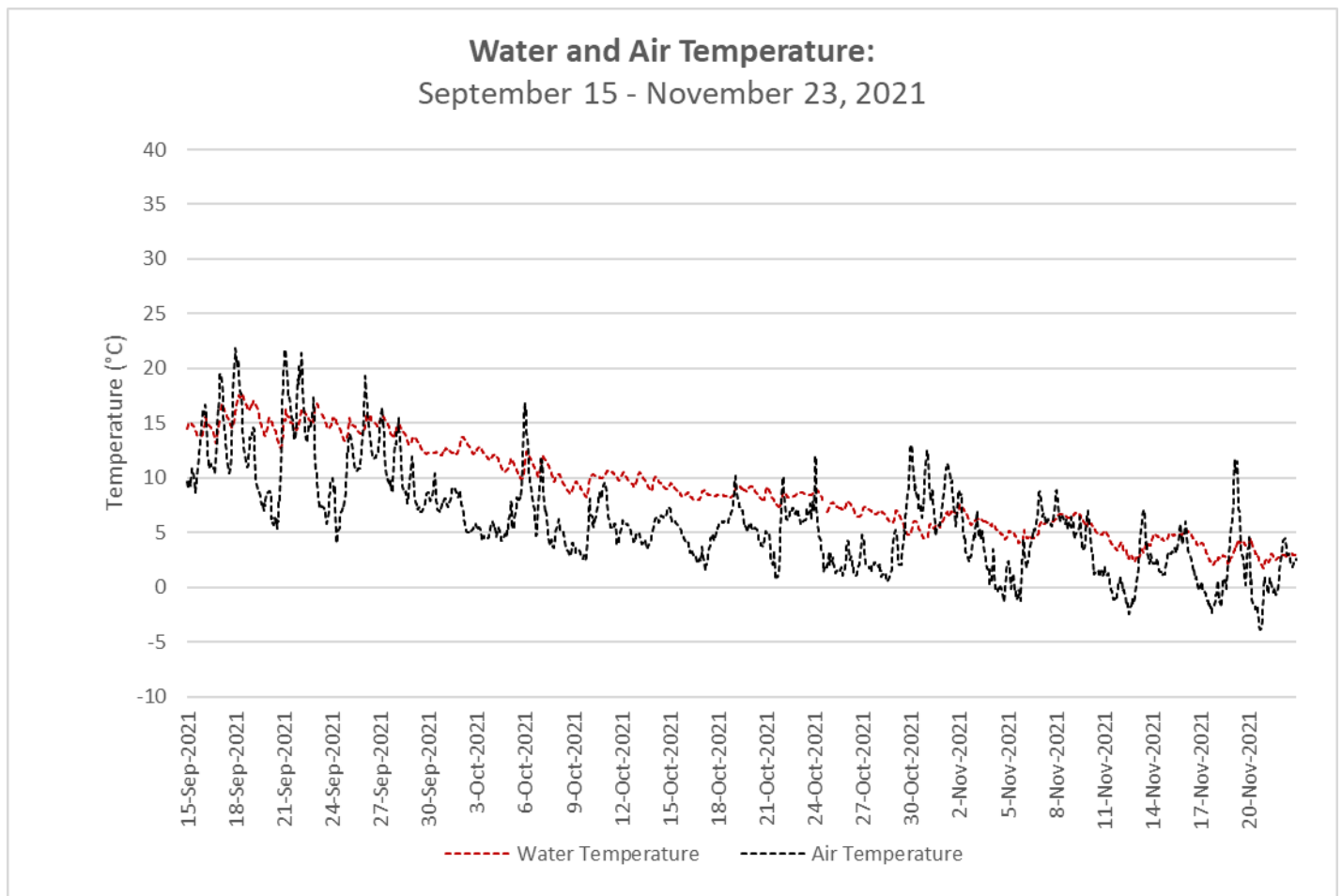


Figure 2: Water and Air Temperature – Outflow of the Steady
(Weather data collected at La Scie)

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- pH ranged between 6.80 and 7.13 pH units throughout the deployment period, with a median value of 6.92 units (Figure 3).
- All values during the deployment are within the CCME Guidelines for the Protection of Aquatic Life (between 6.5 and 9 pH units). pH fluctuates slightly during the day and night.
- Significant rainfall (evident as a rise in stage levels) can cause a slight dip in pH levels, as evident September 30 (Figure 3). This is a common occurrence in freshwater as the slightly acidic rain influences the overall pH of the river for a short period of time.
- Overall, pH was stable during the deployment.

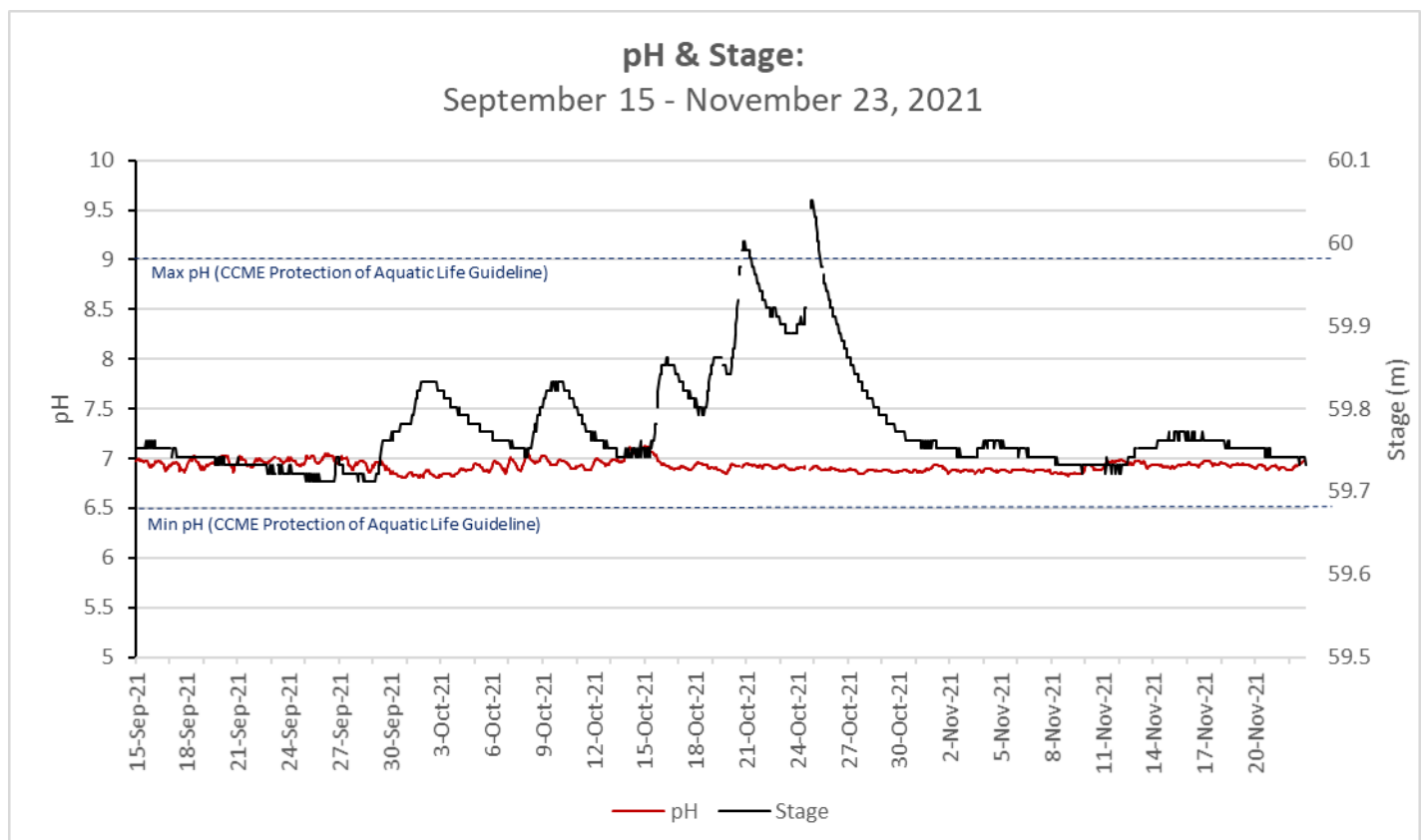


Figure 3: Water pH & Stage – Outflow of the Steady

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- Specific conductivity ranged from 122.0 to 165.8 $\mu\text{S}/\text{cm}$ (Figure 4).
- Specific conductivity was relatively stable throughout the deployment with minor fluctuations inversely related to stage increases from precipitation which diluted the system.
- All data used in the preparation of the graphs and subsequent discussion adhere to this stringent QA/QC protocol. Corrected data can be obtained upon request.

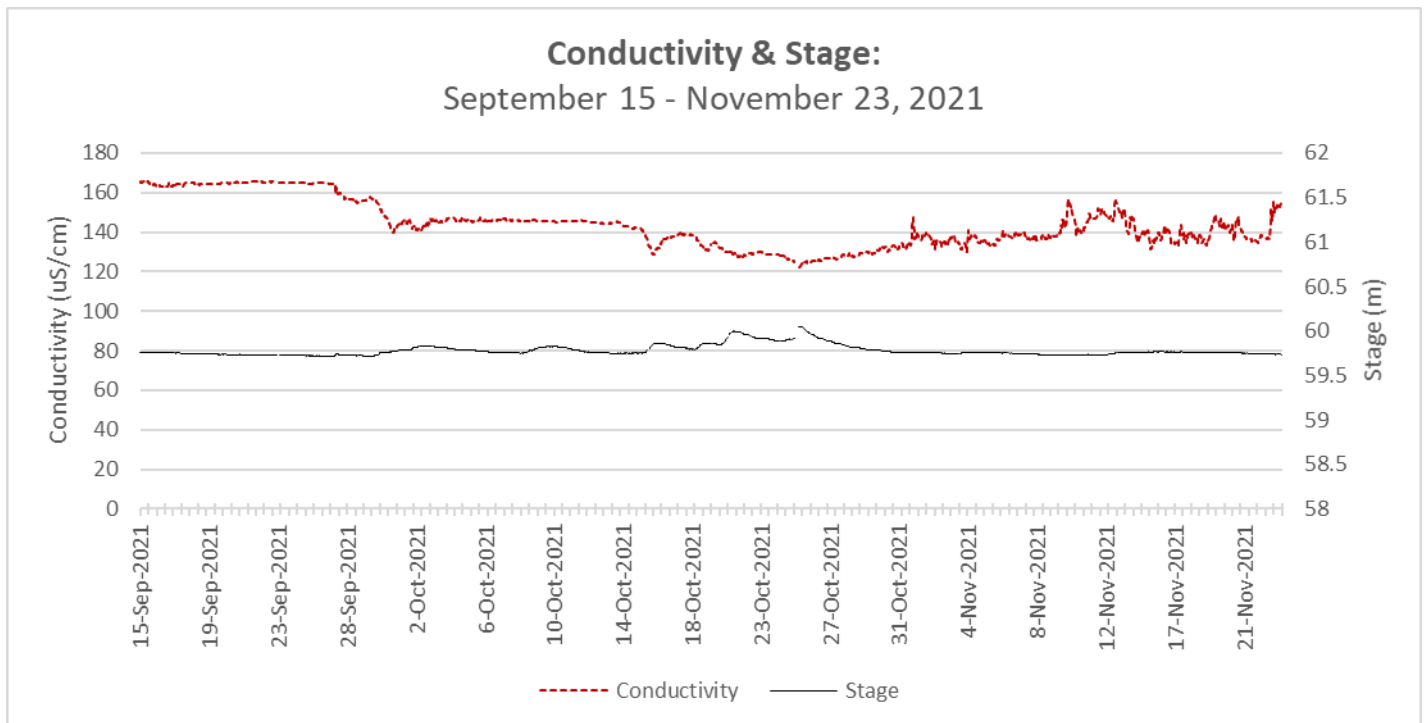


Figure 4: Water Specific Conductivity & Stage - Outflow of the Steady

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- The saturation of dissolved oxygen ranged from 89.6% to 102.3% and a range of 9.21 to 13.39 mg/l was recorded for the concentration of dissolved oxygen with a median value of 11.51 mg/l (Figure 5).
- All values were above the minimum CCME Guideline for the Protection of Other Life Stages of Cold Water Biota of 6.5 mg/l. The majority of values were above the minimum CCME Guideline for the Protection of Early Life Stages of Cold Water Biota value of 9.5 mg/l. The guidelines are indicated in dark blue on Figure 5.
- Dissolved oxygen content fluctuates diurnally, displaying the inverse relationship to water temperature. Dissolved oxygen increased during this deployment period as water temperatures cooled into Fall.

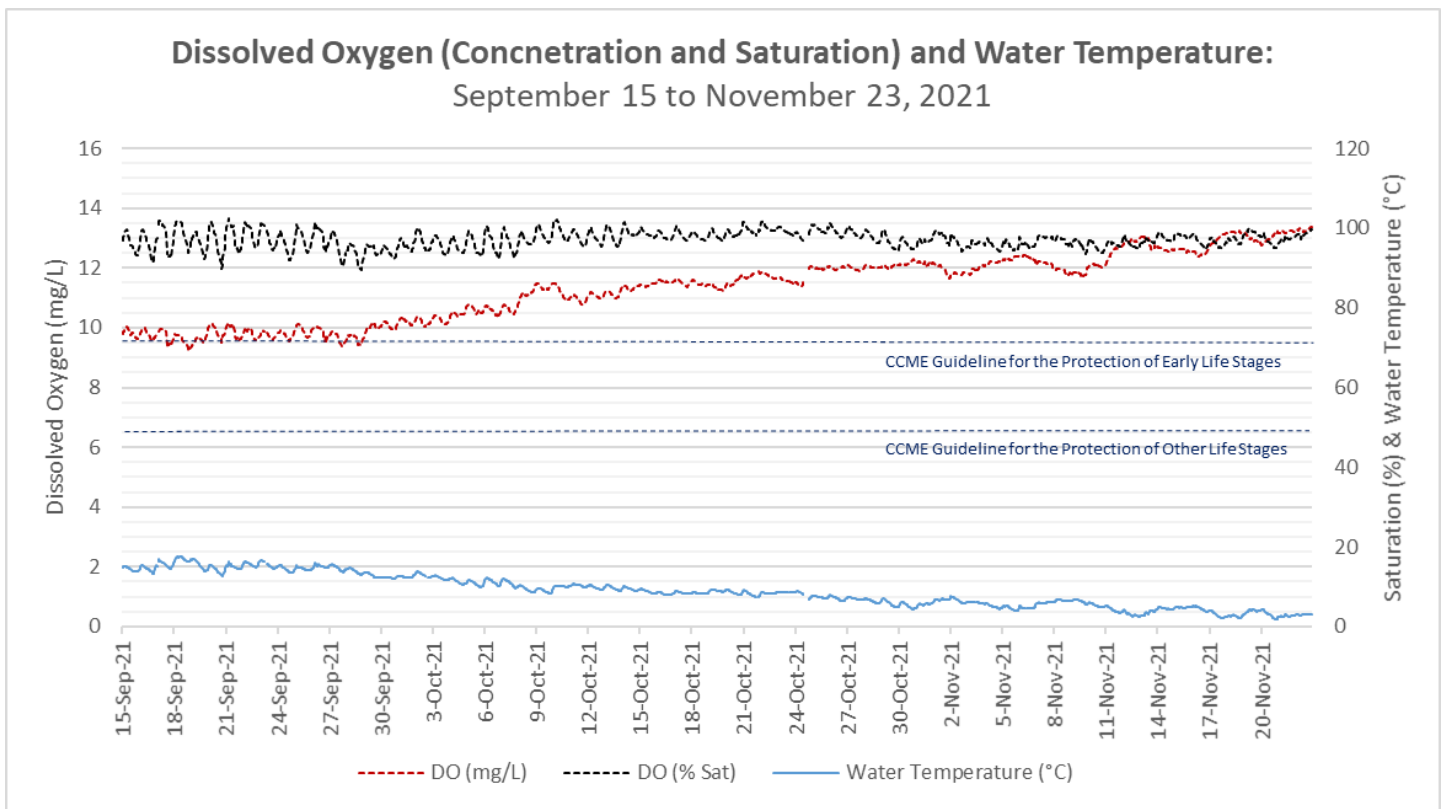


Figure 5: Dissolved Oxygen and Water Temperature – Outflow of the Steady

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- Turbidity values range from 1.0 NTU to 3.5 NTU with a median of 1.2, indicating very clear background turbidity.
- Turbidity increased when water levels increased and decreased when stage decreased (Figure 6). This indicates rainfall may assist in flushing out sediment from the brook but also temporarily suspends particles in the water column for a short time.

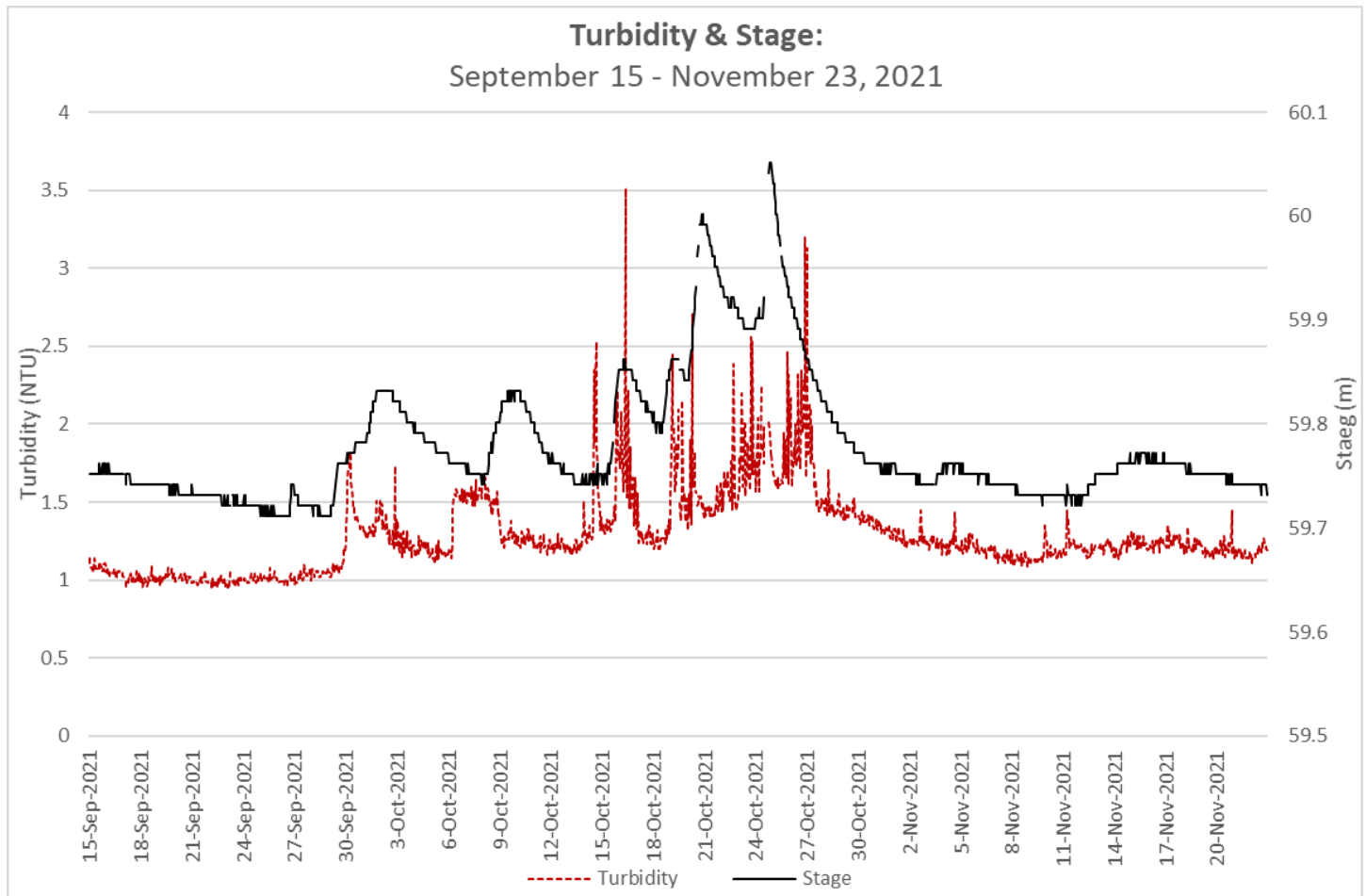


Figure 6: Turbidity and Stage – Outflow of the Steady

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- Precipitation and stage during the deployment period are graphed below (Figure 7). Stage was influenced by precipitation events.
- With the exception of water quantity data (stage), all data used in the preparation of the graphs and subsequent discussion below adhere to this stringent QA/QC protocol. Corrected data can be obtained upon request.

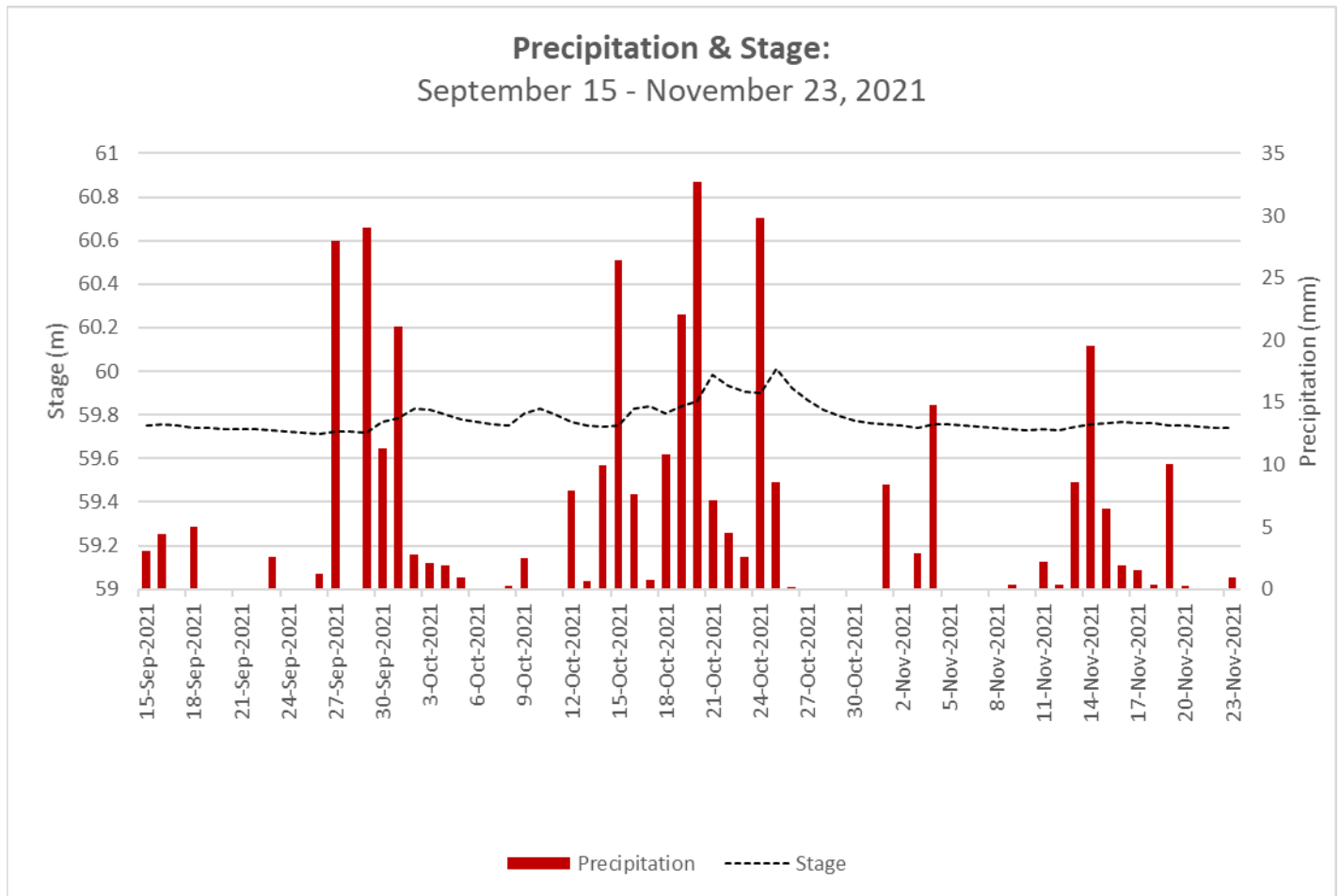


Figure 7: Precipitation and Stage – Outflow of the Steady

Conclusions

- An instrument was deployed at the Outflow of the Steady water quality monitoring station on September 15 and removed on November 23, 2021. This was the third and final deployment of the 2021 season.
- In most cases, weather related events or increases/decreases in water level explain parameter fluctuations.
- Water temperature decreased during the deployment period, ranging from 1.76 to 17.57°C. The data confirmed water temperature was corresponding with ambient air temperatures.
- pH values were all within the recommended CCME Guidelines for the Protection of Aquatic Life. pH ranged between 6.80 and 7.13. The brook is influenced by high precipitation events which decrease pH values for a short time.
- Specific conductivity ranged from 122.0 to 165.8 $\mu\text{s}/\text{cm}$, with variations inversely related to stage/precipitation.
- Dissolved oxygen values were above the minimum CCME Guideline for the Protection of Other Life Stage Cold Water Biota of 6.5 mg/l. The majority of values were above the minimum CCME Guideline for the Protection of Early Life Stage Cold Water Biota value of 9.5 mg/l. The values below this guideline correspond with higher water temperatures.
- Turbidity values of 1.0 NTU to 3.5 NTU indicated low background turbidity. Increasing turbidity corresponded to increases in the water level at this site.
- Stage was stable during this deployment period except when influenced by precipitation events.
- With the exception of water quantity data (stage), all data used in the preparation of the graphs and subsequent discussion adhere to this stringent QA/QC protocol. Corrected data can be obtained upon request.

Prepared by:
Jason Barnes
Department of Environment & Climate Change
Water Resources Management Division
Phone: 709.637.2431

Appendix 1

